Chapter one

1-1 Introduction: -

Lower Limb Disorders (LLDs) at work affect the hips, knees and legs and usually happen because of overuse - workers may report lower limb pain, aching and numbness without a specific disease being identified, Acute injury caused by a violent impact or extreme force is less common. However, athletes and military personnel are more prone to these injuries so workers who take part in these activities may report them at work(Graham et al 2000).

Scientific evidence suggests that there are several recognized diseases of the lower limb which can be work related such as: hip and knee osteoarthritis; knee bursitis, meniscal lesions/tears; stress fracture/reaction injury and varicose veins of the lower legs.

Lower limb artery disease also referred to as peripheral artery disease (PAD) is the most common disease which occurs when the blood vessels that supply blood to the limbs and other organs of our body are partially or completely blocked due to plaque build-up. This is a condition called atherosclerosis. Plaque forms out of the substances present in blood such as fat, cholesterol, calcium and fibrous tissue. These plaque deposits gradually harden and narrow the opening of the arteries. This limits the oxygen-rich blood supply to the parts of your body. The most commonly affected blood vessels due to PVD are the arteries of the legs (Graham et al 2000).

1-2 Problem of study:

Multi-Detector Row Computed Tomography Angiography (MDCTA) is increasingly used to peripheral arterial to diagnosis any abnormalities of artery and vinous, and There is no reference for Sudanese patient for measurement of abdominal aorta and femoral artery in CT Angiography.

1-3 Objectives of the study:

1.3.1 The general objectives:

Determination of normal femoral artery diameter in Sudanese population by using Computed Tomography .

1-3-2 Specific objective:

- Identify femoral artery diameter in Sudanese population.
- Correlate the difference between the left and right femoral artery side.
- Correlate the dimension of femoral artery according to gender
- Correlate the dimension of femoral artery according to age

1-4 Overview of the study

This study falls into five chapters. Chapter one is consist of introduction, problem of the study, general, specific objectives and significant of the study. Chapter two concerns with literature review of peripheral CTA. Chapter three is about the methodology which includes material and method, chapter four about the result presentation, chapter five about the discussion, conclusion, recommendation and limitations including the references and appendixes.

Chapter Two

Literature Review

2-1 Anatomy:

2-1-1 Arteries of the Pelvis and Lower Extremity:

The abdominal portion of the aorta terminates in the posterior pelvic area as it bifurcates into the right and left common iliac arteries. These vessels pass downward approximately 5 cm on their respective sides and terminate by dividing into the *internal* and *external iliac arteries.*

organs of the female. The muscles of the buttock are served by the superior and inferior gluteal arteries. Some of the upper medial thigh muscles are supplied with blood from the obturator artery. The internal pudendal artery of the internal iliac artery serves the musculature of the perineum and the external genitalia. During sexual arousal it supplies the blood for vascular engorgement of the penis in the male and clitoris in the female.

The external iliac artery passes out of the pelvic cavity deep to the inguinal ligament (fig. 16.31) and becomes the femoral (*fem*'*or-al*) artery. Two branches arise from the external iliac artery, however, before it passes beneath the inguinal ligament.

An inferior epigastric artery branches from the external iliac artery and passes superiorly to supply the skin and muscles of the abdominal wall. The deep circumflex iliac artery is a small branch that extends laterally to supply the muscles attached to the iliac fossa.

The femoral artery passes through an area called the femoral triangle on the upper medial portion of the thigh (figs. 16.31 and 16.32). At this point, it is close to the surface and its pulse can be palpated. Several vessels arise from the femoral artery to serve the thigh region. The largest of these, the deep femoral artery, passes posteriorly to serve the ham string muscles. The lateral and medial femoral circumflex arteries encircle the proximal end of the femur and serve muscles in this region. The femoral artery becomes the popliteal (*pop''li˘-te'al*) artery as it passes across the posterior aspect of the knee.

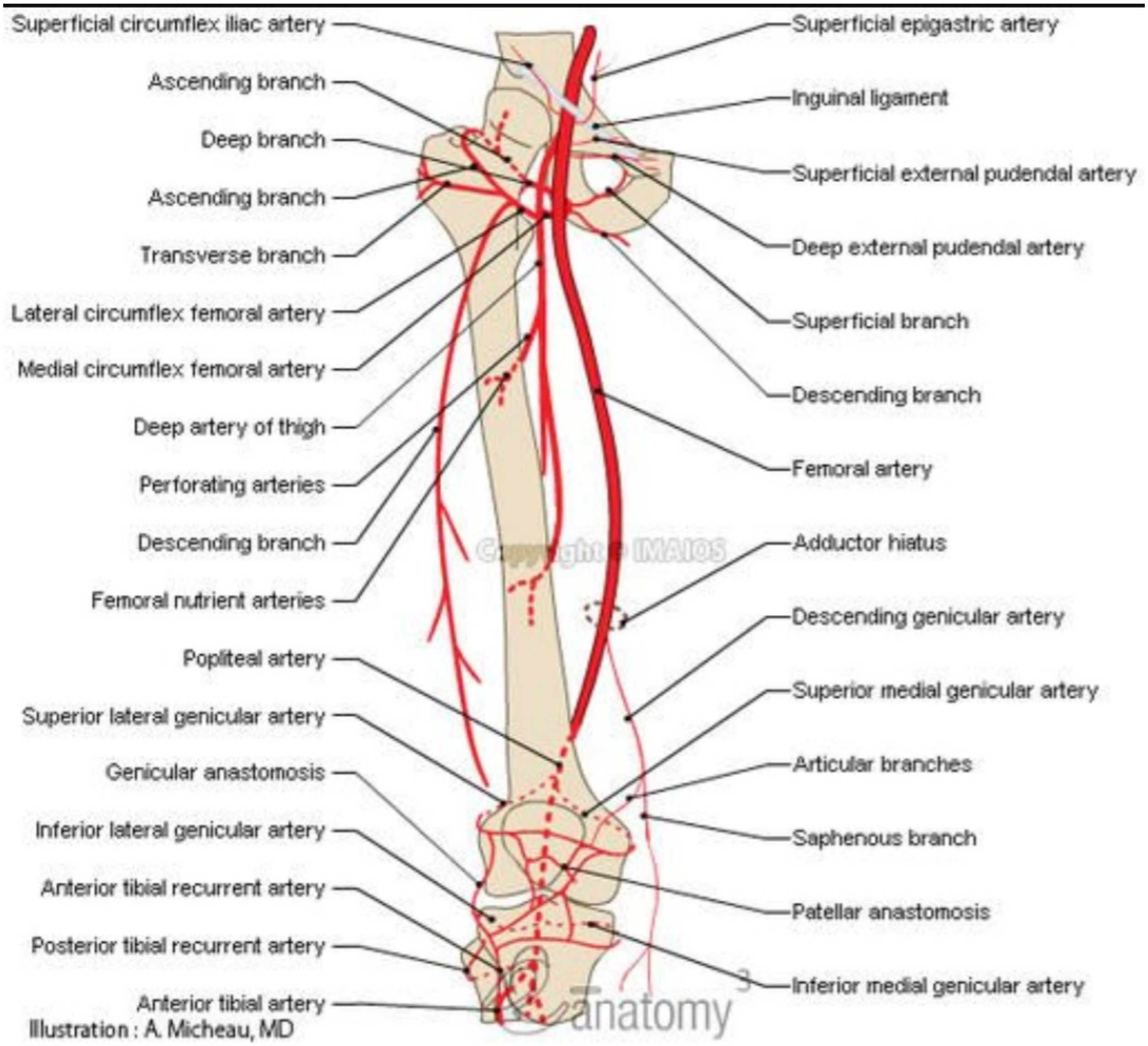

Fig 2.1 Anatomy of the femoral artery

2-2 Physiology:

2-2-1 Effect of High Right Atrial Pressure on Peripheral Venous Pressure:

When the right atrial pressure rises above its normal value of 0 mm Hg, blood begins to back

up in the large veins. This backup of blood enlarges the veins, and even the collapse points in the veins open up when the right atrial pressure rises above 4 to 6 mm Hg(John E. Hall et al 2006).

Effect of Intra-abdominal Pressure on Venous Pressures of the Leg: The pressure in the abdominal cavity of a recumbent person normally averages about 6 mm Hg.

Effect of Gravitational Pressure on Venous Pressure: In any body of water that is exposed to air, the pressure at the surface of the water is equal to atmospheric pressure, but the pressure rises 1 mm Hg for each 13.6 millimeters of distance below the surface. This pressure results from the weight of the water and therefore is called gravitational pressure or hydrostatic pressure. Gravitational pressure also occurs in the vascular system of the human being because of weight of the blood in the vessels. When a person is standing, the pressure in the right atrium remains about 0 mm Hg In the arm veins, the pressure at the level of the top rib is usually about ᇂ6 mm Hg rib is usually about 6 mm Hg. (John E. Hall et al 2006).

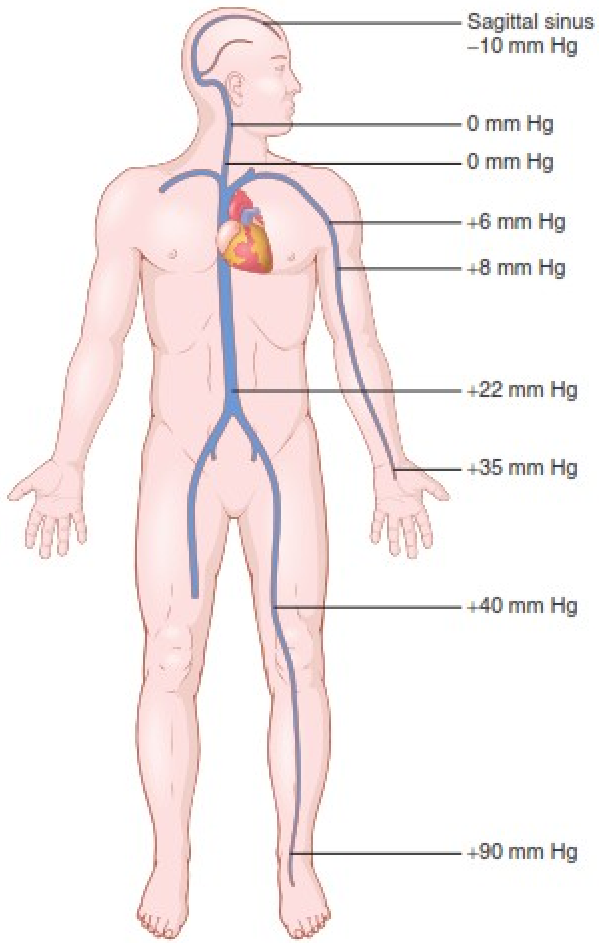

Fig 2.2 effect of gravitational pressure on the venous pressures through out the body in the standing person

of the subclavian vein as it passes over this rib. The gravitational pressure down the length of the arm then is determined by the distance below the level of this rib. Thus, if the gravitational difference between the level of the rib and the hand is 29 mm Hg compression of the vein as it crosses the rib, making a total of 35 mm Hg almost completely all the way to the skull because of atmospheric pressure on the outside of the neck. This collapse causes the pressure in these veins to remain at zero along their entire extent. Any tendency for the pressure to rise above this level opens the veins and allows the pressure to fall back to zero because of flow of the blood. Conversely, any tendency for the neck vein pressure to fall below zero collapses the veins still more, which further increases their resistance and again returns the pressure back to zero, The veins inside the skull, on the other hand, are in a noncollapsible chamber (the skull cavity) and thus they cannot collapse. Consequently, negative pressure can exist in the dural sinuses of the head; in the standing position, the venous pressure in the sagittal sinus at the top of the brain is about 10 mm Hg   “suction” between the top of the skull and the base of the skull. Therefore if the sagittal sinus is opened during surgery, air can be sucked immediately into the venous system; the air may even pass downward to cause air embolism in the heart and death.

2-3 Imaging:

2-3-1 CT Angiography:

CT angiography CTA exam has to be performed by using a 64-row scanner before and during infusion of contrast medium (370-400 mgI/ml). Patients were in the supine position with their feet first. a thick-slice pre-contrast acquisition must always be performed to reveal calcifications and to plan the following contrast-enhanced examination, by selecting the volume of acquisition and placing a region of interest in the aorta at the level of the aortic arch. Thin-slice arterial-enhanced images are obtained from 2 cm above the origin of renal arteries to the ankle. CTA-acquisition protocol parameters are the following: 0.625x64mm collimation, 0.7-second gantry rotation, pitch 0.9; scan duration ranged between 18 and 25 seconds (R.Lezzi et al 2003).

Contrast-enhanced images are obtained during bolus intravenous injection of 80-120 ml of a high-concentration iodinated non-ionic contrast medium (370-400mgI/mL) + 40mL of saline solution, administered with an automated injector at a flow rate of 4 ml/s via an antecubital vein.

A very important achievement in CT-angiography is the optimal contrast-medium dynamic. As a matter of fact, scanning should start when the examined structured have reached an ideal level of opacification; therefore, scan delay has to be individualized per patient, using bolus-tracking software. However, with the increased speed of the new scanner generation (until 90 mm/sec possible with a 64-detector row scanners), if the CT data acquisition is initiated at the time of contrast medium bolus arrival in the aorta, the CT acquisition may outpace the bolus, with resultant inadequate opacification of arteries, to avoid this problem, we suggest to decrease the table speed (until to 30mm/sec) increasing the scanning delay by selecting an appropriate "diagnostic delay" (interval of time between automated detection of the contrast medium bolus arrival within the target vessel and the real initiation of the CT angiographic data acquisition) (R.Lezzi et al 2003).

Our contrast-medium injection protocol suggest to use a bolus-tracking software capturing 150 HU on the abdominal aorta, at the level of the celiac trunk, to trigger scanning and ensure a correct peak enhancement, by adding a diagnostic delay of 8 seconds in order to avoid to outpace the bolus. In a limited number of patients with large aorto-iliac and femoro-popliteal aneurysms, an optional second acquisition (from the knees to the feet) should be preprogrammed and initiated immediately after the first acquisition if reconstructions of the initially acquired CT data show no opacification of the distal arteries (R.Lezzi et al 2003).

2.4 method of measurement:

The measuerment was done using measurement tools of the DICOM system and tooles which is found in CT machine from inner wall of the artery in coronal and axial cuts in levels of upper , medium and lower femoral artery .

2-5 Previous study:

Edwards et al 2005 assess whether multi-detector CT angiograms (MDCTA) of the lower limb arteries, compared with conventional digital subtraction angiograms (DSA), could replace invasive arteriography in patients with symptomatic peripheral arterial disease.

In a prospective comparative analysis of MDCTA and DSA in 44 patients, MDCTA was analyzed using volume-rendered images acquired at a

workstation and viewed in tandem with the original axial data. Designated arterial segments were graded according to their degree of stenosis.
And found agreement for the degree of stenosis in 88.8% and 85.4% of 1024 segments analyzed for two observers. The sensitivity for treatable lesions (>50% stenosis) was 79.1% and 72% with a specificity of 93.3% and 92.6%. DSA failed to visualize 7.3% of segments that were visible with MDCTA. These segments were exclusively downstream to long segment occlusions. Conclusion: medical using 4-slice machines is insensitive to detecting significant arterial stenoses in the lower limb arteries. MDCTA is superior to DSA in its visualization of arterial territories downstream to significant occlusive disease.

T.Lanne et al 2000, Objectives To study 40-55 mm aneurysms and calculate their size in relation to the individual predicted normal aortic diameter to see if this might add anything in the evaluation of treatment.
The anteroposterior diameter of 40-55 ,mm AAAs was measured with an echo-tracking ultrasonic technique in 147 consecutive patients. The weight and height were registered and body surface area calculated. The predicted normal aortic diameters were defined according to nomograms and the diameter increase from the predicted normal aortic size in the individual aneurysms calculated.

The median AAA diameter was 48 mm (range 40-55), the BSA 1.85 m 2 (1.42-2.37), and the predicted AO size 19.4 mm (14.3-21.6). The calculated increase of size in the individual aneurysms was 2.51 (1.9-3.53), that is the spread of data doubled as compared to conventional diameter measurements. When females and males were studied separately the AAA diameter was 46.5 mm (40-55) and 48 mm (40-55), respectively (NS). Since the BSA was significantly lower in women than in men, 1.63 (1.42-1.95) and 1.89 (1.47-2.37), respectively (p<O.O001), also the predicted normal aortic size was lower, 16.4 (14.3-17.8) vs. 19.7 (18.0-21.6) (p<O.O001). Thus, the AAA diameter increase from the predicted size was larger in women than in men; 2.93 (2.25-3.53) vs. 2.46 (1.90-2.94), respectively (p<O.O001).

To define an aneurysm as a localised dilatation of an artery exceeding 50% of the expected normal diameter is now possible. This may facilitate how to treat especially smaller aneurysms and give new information concerning patterns of growth and risk of rupture.

Chapter Three

Material and Methods

3-1 Materials:

This study intended to normal patients and measure the diameter of abdominal aorta bifurcation and the left and right femoral artery (upper, medium and lower) parts. The data was collected in two hospital Royal Care International Hospital and Alatebaa hospital in period march to August 2015.

3-1-1 Patients:

All patients refer to the hospital for lower limb disease having the characteristics signs and symptoms of lower limb artery disease for the first time i.e. he/she did not receive medication and their age above 40 years.

3-1-2 Machine:

All patients examined on a Helical Multi detector CT scanner scanner (CXXG-012A Toshiba scanner 64 slice, Philips 64 slice) at Royal Care International Hospital and Alatebaa Hospital respectively, used for collecting data sheet from CT Angiography.

3-1-3 Sample size and type:

The sample of this study is of a convenient type will consisted of 50 patients suffering from lower limb diseases.

3-1-4 Design of the study:

This is a descriptive cross-section study where a representative sample of patient will be collected from radiology department Doctors hospital and RCIH CT department during the period from March to August 2015.

3-2 Method of data collection:

3-2-1 Technique:

There are no specific pre-scanning preparations necessary for MDCTA of the peripheral arteries. The patient is placed comfortably to avoid movement, in the supine position with raised arms on the CT table. The legs are stabilized with cushions around the legs and slightly strapped with adhesive ta distally. It is important that the patient does not wear metal zippers or buttons on their clothing, since this can have a negative influence on the image quality, especially when using postprocessed images. Oral contrast should not be used, as this complicates postprocessing display. Contrast material needs to be administered at body temperature to decrease the viscosity. The protocol can be completely programmed into the scanner.

3-2-2 Data analysis:

The data will be analyzed by using Excel and SPSS software under windows by portraying the frequency distribution of the patient age, lower arterial limb diseases, and linear association of the age, diabetes and gender with the type of lower limb arterial disease.

3.3 Ethical approval

The ethical approval was granted from the hospital and the radiology department; which include commitment of no disclose any information concerning the patient identification.

Chapter Four

Results

Table 4.1 show statistical parameters of measurement the dimensions to abdominal aorta and bifurcation to left and right femoral artery all patients:

	Mean	Median	STD	Min	Max
Lower Lt	7.68	8	1.113	5	10
Medium Lt	7.96	8	1.117	5	10
Upper Lt	8.12	8	1.206	5	11
Lower Rt	8.10	8	1.199	5	11
Medium Rt	8.04	8	1.117	5	10
Upper Rt	8.14	8	1.195	6	11
Bifurcation	16.48	17	1.832	12	22

Table 4.2 measurement of dimensions of abdominal aorta and bifurcation to left and right femoral artery according to gender:

	Gender	Mean	Median	STD	Min	Max
Lower Lt	***Male***	7.78	8	1.121	5	310
	Female	5.57	8	1.161	5	10
Medium Lt	***Male***	8.07	8	1.238	5	10
	Female	7.83	8	1.114	6	10
Upper Lt	***Male***	8.41	8	1.279	5	11
	Female	7.78	8	1.043	6	10
Lower Rt	***Male***	8.33	9	1.330	5	11
	Female	7.83	8	0.984	6	10
Medium Rt	***Male***	8.33	9	1.209	5	10
	Female	7.70	8	1.118	6	10
Upper Rt	***Male***	8.59	9	1.083	7	11
	Female	7.61	8	1.118	6	10
Bifurcation	***Male***	16.74	17	1.810	13	22
	Female	16.17	16	1.850	12	20

Table 4.3 show linear regression between the age and other variables using ANOVA

Model	Unstandardized Coefficients		Standardized Coefficients	t	P.value
	B	Std. Error	Beta		
lower Lt	-.075	.405	-.056	-.186	.854
medium Lt	.024	.480	.019	.051	.960
upper Lt	-.043	.267	-.034	-.159	.874
lower Rt	-.649	.452	-.514	-1.434	.159
medium Rt	.444	.594	.345	.748	.459
upper Rt	-.410	.308	-.324	-1.334	.189

Figure 4.1 show correlation between upper right and upper left femoral artery

Figure 4.2 show correlation between middle right and meddle left femoral artery

Figure 4.3 show correlation between lower right and lower left femoral artery

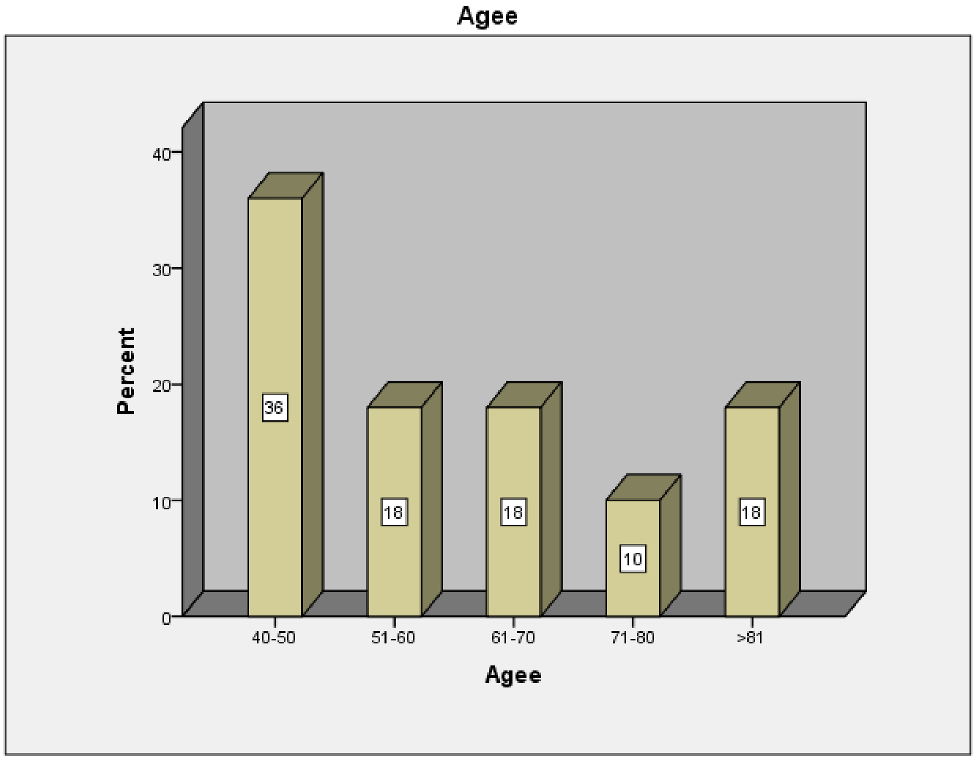

Figure 4.4 show frequency percentage of Age period over all samples

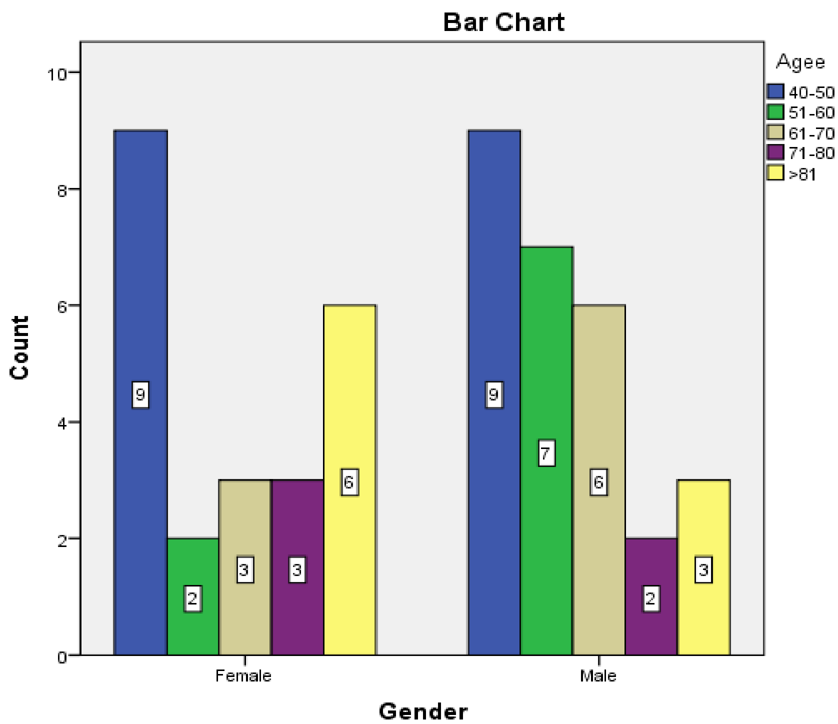

Figure 4.5 show correlation between Age period with Gender

Chapter Five
Discussion, Conclusion and Recomendation

5-1 Discussion:

Measurement of abdominal aorta and its bifurcation to left and right ileac then to left and right femoral artery in regard to 100 patients with Computed Tomography Angiography to lower limb, where all measures done in MDCT in Toshiba 64 slice and helping with RadiAnt DICOM viewer.

Statistical measurement of bifurcation of abdominal aorta to left and right femoral artery using paired sample statistic mean and STD, for the lower left femoral artery mean ± SD its 7.74±1.11 and for right lower 7.99±1.11, and the left medium 7.89±1.11 and for right medium 7.96±1.16, and the left upper femoral artery 8.07±1.17 and right upper 8.1±1.11.

Measurement of dimensional of abdominal aorta and the bifurcation to left and right femoral artery according to gender male and female. In the left site The lower left for male 7.78±1.12 and for female 5.57±1.16, the medium left femoral artery for male 8.07±1.24 and for female 7.83±1.14, and the left upper in male 8.41±1.28 and for female 7.78±1.04, and the measurement for the femoral artery in the right site the right lower artery for male 8.33±1.33 and the female 7.83±0.98, and the right medium for male 8.33±1.21and the female 7.70±1.12, and the upper right for male 8.59±1.08 and the female 7.61±1.12.

and correlation between lower right and lower left femoral artery and the value of relation (R2=0.64) which mean there is a strong relation between the lower right and lower left.

The correlation between the age and upper , medium and upper femoral artery shows no significant difference between the age and the upper , medium and lower femoral artery according to P. Value (0.05).

This study agrees with Thomas Sandgren et al 1999 The CFA increased steadily in diameter throughout life. From 25 years onwards,the diameter was larger in men than in women. Significant correlations were found between the CFA diameter and weight (r = 0.58 and r = 0.57 in male and female subjects, respectively.

5-2 Conclusion:

The study conducted to determination of normal femoral artery diameter in Sudanese population using Computed Tomography, the dimension of abdominal aorta and the right and left femoral artery its bigger in male than female and for right and left femoral artery bigger in male than female and the diameter decrease with age may be due to decrease of movement and physical effort.

correlation between upper right and upper left femoral artery and the value of relation (R^2=0.48) which mean there is a strong relation between the Upper right and Upper left.

correlation between middle right and middle left femoral artery and the value of relation (R^2=0.82) which mean there is a strong relation between the , meddle right and middle left.

And correlation between lower right and lower left femoral artery and there is a strong relation between the lower right and lower left.

5.3 Recommendations:

- More study Include a disease of peripheral arteries; abdominal aorta and femoral artery disease.
- Further studies using other modalities MRI and Ultrasound.
- Further study with large samples.
- All hospital should use the Picture Archiving Communication System.

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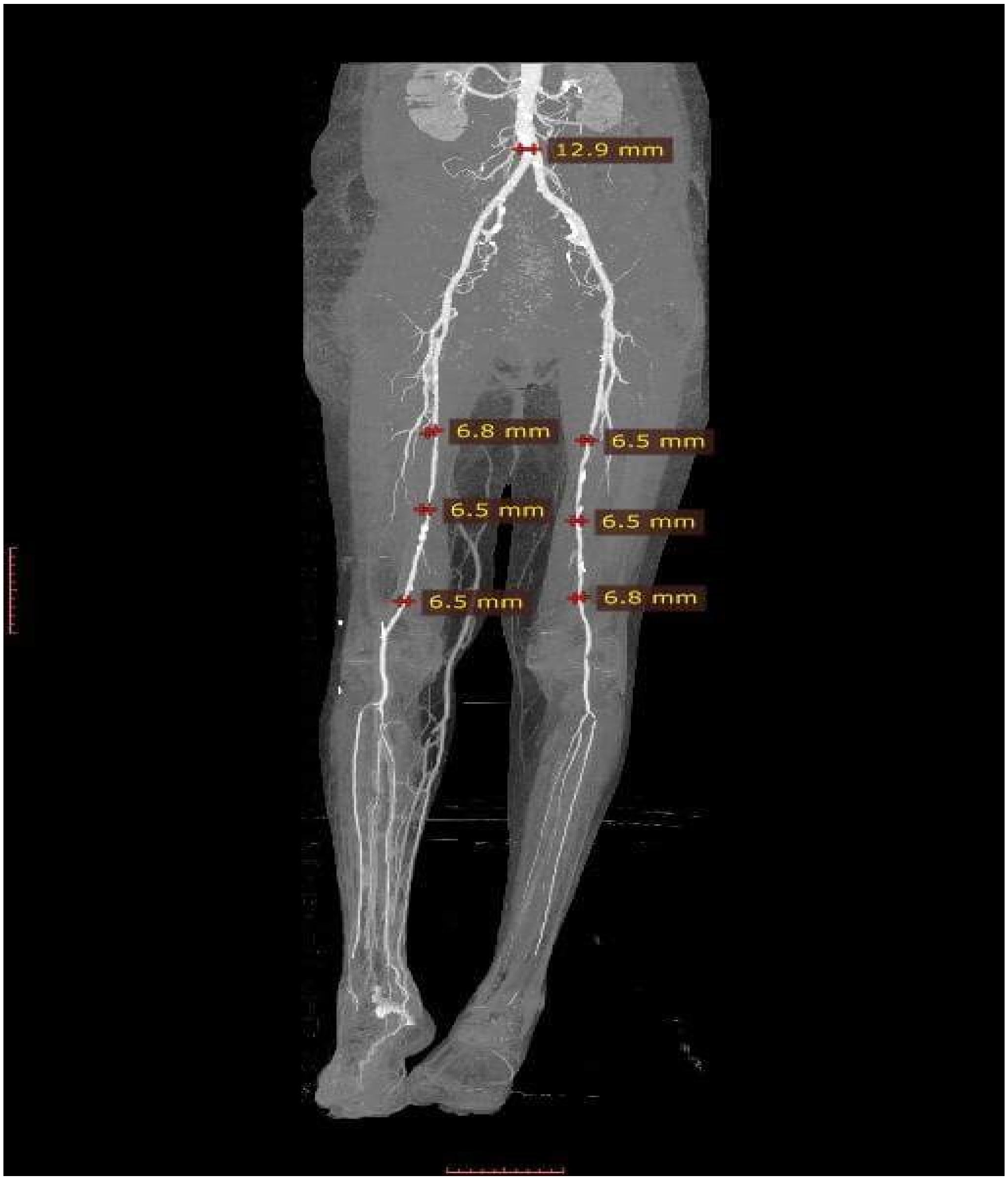
Appendix (A): Data collection sheet:

Gender	Age	Diam abd aort	Upper RT F.A	Med RT F.A	Low RT F.A	Upper Lt F.A	Med Lt F.A	Low Lt F.A

Appendix (B)



Show measurement method of upper medium and lower femoral artery

CT angiography shows both femoral arteries for 43 female patient